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R. J. BIERSNER & J. M. LA ROCCO

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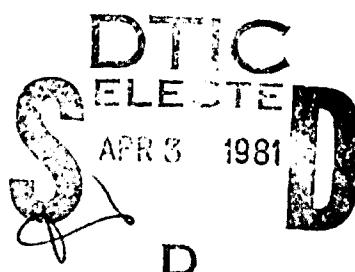
NAVAL HEALTH RESEARCH CENTER
P. O. BOX 85122
SAN DIEGO, CALIFORNIA 92138

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND

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DETERMINANTS OF
READING PERFORMANCE AND ACHIEVEMENT[1]

ROBERT J. BIERSNER AND JAMES M. LAROCCO

Naval Medical Research and Development Command

Summary.—Verbal, nonverbal, demographic, and eye-hand laterality measures were administered to a sample of 34 Navy recruits attending a remedial reading program and 53 recruits who were members of a regular recruit company. Verbal intelligence scores (as determined by the General Classification Test) differentiated best between the remediation and non-remediation groups. Race (being non-Caucasian) was also associated positively with the need for reading remediation. Reading achievement within the remedial group was related positively to race (being non-Caucasian). These results indicate that low intelligence and cultural factors may account for deficient reading performance among Navy recruits. The results also show that, while self-reported measures of laterality may not be especially useful in screening for remedial readers, these measures may nonetheless serve to identify neuropsychological factors that may underlie the condition.

Effective performance in the military, as well as many other occupational groups, is highly dependent on reading skills. Hoiberg, Hysham, and Berry (1974) have shown that successful completion of the first 4-yr. enlistment period in the Navy is related significantly to reading skills, while Fisher (1971) found similar results for Army personnel. This research, as well as the research of others (Stuart, 1967), has shown that non-Caucasians (principally blacks) have poorer reading skills than Caucasians.

Previous research has demonstrated high correlations between conventional tests of verbal intelligence and reading performance among both adults and children (Chester, 1974; Sticht, 1968). Inasmuch as most of those who may require remedial reading may not be from the majority culture on which the verbal intelligence tests were developed, the screening program should include measures that have demonstrated less cultural bias than conventional verbal intelligence tests. A test that appears to satisfy this criterion is Raven's Progressive Matrices. Similar reliabilities, validities, norms, and factors have been found for the Matrices among several different cultural groups (Baraheni, 1974; Burke, 1958; Corman & Budoff, 1974).

Measures of handedness and eyedness (laterality) may also be useful in screening poor readers. Harris (1962) presented evidence that ambilaterality (equal use of both hands and eyes) may be related to reading difficulties among

children, while Palmer (1974) has mentioned that lateral consistency (use of the same side across several tasks) may be useful in predicting a variety of performance, including reading.

The following research will analyze which characteristics differentiate between poor and effective readers and which characteristics are related to reading achievement under the present Navy remediation programs.

METHOD

Subjects

Subjects were 87 male recruits attending the third week of Navy basic training at the Recruit Training Command (RTC), San Diego, California. Thirty-four of the recruits (the RR group) were attending the first week of a 6-wk. remedial reading program, having been placed into the remediation program after failing the first written examination and obtaining a comprehension score below the fifth grade on the Gates-MacGinitie Reading Test. The remaining 53 recruits (comparison group) were members of a single recruit unit (or company) selected at random from the Training Command and were progressing normally through recruit training.

Procedure

Testing sessions.—The two groups were tested three days apart, at the same hour each day. The tests described below were contained in a booklet with a separate answer sheet. The measures were group-administered. In order to avoid bias that could result from reading problems, the written questions were read slowly to each group and repeated if necessary.

Verbal intelligence.—The General Classification Test was used as the principal measure of verbal intelligence. This test consists of verbal analogies and sentence completions. The test has been standardized on a large, unrestricted recruit sample consisting mostly of lower and middle class Caucasian males.

Nonverbal intelligence.—The Raven Progressive Matrices was used as a nonverbal measure of intelligence. The 40 incomplete test patterns were contained in a booklet with a single, incomplete test pattern on the upper half of each page. The bottom half of the page contained five possible completion patterns, only one of which was correct. The score was the total number of completion patterns chosen correctly (without a time limit).

Demographic measures.—Demographic data included race (scored as 1 = Caucasian, 2 = non Caucasian), age (yr.), education level (yr.), and whether or not English was a second language (scored as 1 = Yes, 2 = No). The recruits were also asked if they had ever used the other hand for writing (referred to as "Modified Hand Use" and was scored as 1 = Yes, 2 = No).

Laterality test: handedness.—A slightly modified version of the laterality

test developed by Crovitz and Zener (1962) was used to test for handedness and eyedness (laterality). Most of the 14 handedness items developed by Crovitz and Zener were used in the present test with a few exceptions. The Crovitz and Zener item concerning which hand is used to hold a dish when wiping was modified to read "Which hand do you use to hold a shoe when polishing?" (a question that is more relevant to this sample). The Crovitz and Zener item asking which hand is used to hold a tennis racket was modified to include either a tennis racket or ping pong paddle. An additional item, not included in the original 14 items, asked "Which hand do you use to hold a fork when eating?" The 5-point scale originally developed by Crovitz and Zener was used for scoring these items.

Laterality test: eyedness.—The laterality test also included the eyedness measure described by Crovitz and Zener. The eyedness measure was included as the sixteenth item in determining the total laterality score. The eyedness test was presented and scored in the same manner used by Crovitz and Zener. For consistency with the handedness items, the 9-point scale for eyedness (ranging from a minimum of 0 left eye responses to a maximum of 8 left eye responses) was transformed to a 5-point scale.

Laterality test: other scores.—Several other measures, derived from the above items, were also used as independent measures. Lateral consistency was determined by calculating the standard deviation about the mean score of the 16 laterality items for each recruit. Ambilaterality was calculated by converting the 5-point scale for each of the 16 laterality items to a 3-point scale, with the extreme scores of "1" and "5" being converted to a "1" (low ambilaterality), scores of "2" and "4" becoming a "2", and the midpoint remaining as a "3" (high ambilaterality). Mixed eye-hand laterality was determined by calculating the average score across the 15 handedness items and subtracting the eyedness score from this average.

Criterion measures.—The two major criteria were (a) the group (RR or comparison) to which the recruits belonged and (b) reading achievement scores attained by the 34 members of the RR group during remedial training. Reading achievement consisted of the difference between comprehension scores earned on the Gates-MacGinitie Reading Test (Survey D, Forms 1 and 2) before and after reading remediation. Forms 1 and 2 were administered in a counterbalanced order during pre- and posttesting.

Statistical Analysis

The independent measures were correlated with the criteria using Pearson product-moment correlations. Those independent measures correlating significantly with the criteria were entered into a step-wise multiple regression analysis in order to determine which of these measures contributed uniquely to the criterion variance. Levels of significance are $p < .05$ (two-tailed).

RESULTS

The means and standard deviations of the 12 independent measures for the two criterion groups (RR and comparison) are listed in Table 1. For correlation purposes, the comparison group was assigned a score of 1 and the RR group was assigned a score of 2. Six of the 12 independent measures correlated significantly with the group criterion. These correlations (see Table 2) indicate that those recruits who were Caucasian, who scored higher on the General Classification Test and Raven's Matrices, as well as those who had more education, who had not used the other hand for writing (lower "Modified Hand Use" scores), and who were consistent in using the hands and eyes were more likely to be members of the comparison group than the RR group. The subsequent step-wise multiple regression analysis resulted in a multiple R of .843 ($p < .0001$), with scores on the General Classification Test and Raven's Matrices, as well as race, accounting independently for criterion variance.

TABLE 1

SUMMARY STATISTICS FOR 12 INDEPENDENT MEASURES
FOR THE EXPERIMENTAL (RR) AND COMPARISON (C) GROUPS

Independent Measure	RR Group ($n = 34$)		C Group ($n = 53$)		t or z as appropriate
	M	SD	M	SD	
Age (yr.)	18.44	1.26	18.26	1.26	0.65
Education (yr.)	11.26	1.07	11.81	1.17	2.19*
Race (% non-Caucasian)	35.29††		0.00		4.64†
English was a Second Language (%)	5.88		3.77		0.46
Modified Hand Use (%)	38.23		11.32		2.96†
General Classification Test	34.38	6.49	53.62	6.58	13.22†
Raven's Matrices	20.59	6.91	31.43	3.83	9.28†
Eyedness Total	2.38	1.35	2.47	1.40	0.29
Handedness Total	24.35	9.11	24.53	11.70	0.08
Grand Total (Eyedness and Handedness)	26.74	8.92	27.00	12.04	0.11
Lateral Consistency	0.89	0.42	0.71	0.36	2.11*
Mixed Eye-Hand Laterality	1.42	1.05	1.32	1.05	0.43

*$p < .05$ (two-tailed); †$p < .01$ (two-tailed); ††10 blacks, two Filipinos and 22 Caucasians.

For the 34 members of the RR group, the average Gates-MacGinitie comprehension score prior to remediation was 4.65 ($SD = 0.76$), while the mean comprehension score following completion of the remedial reading program was 5.90 ($SD = 1.33$). The mean difference between pre- and posttest comprehension scores was 1.25 ($SD = 1.11$). The difference between pre-

TABLE 2

INTERCORRELATIONS, BETA COEFFICIENTS, AND MULTIPLE REGRESSION OF THE MEASURES CORRELATING SIGNIFICANTLY WITH GROUP CRITERION ($N = 87$)

Measure	2	3	4	5	6	Group Criterion
1. General Classification Test	.74†	.30†	−.26*	−.17	−.48†	−.82†
2. Raven's Matrices		.26*	−.38†	−.07	−.35†	−.71†
3. Education			−.03	.21*	−.27†	−.23*
4. Modified Hand Use				.18	.03	.32†
5. Lateral Consistency					.15	.22°
6. Race						.50†

Multiple R with Group Criterion

Measure	Beta	t
General Classification Test	−.58	6.22†
Raven's Matrices	−.23	2.62*
Race	.14	2.02*

$R = .843; p < .001$

*$p < .05$; †$p < .01$.

and posttest comprehension scores was related significantly only to race, with non-Caucasians improving more than Caucasians ($r = 0.34$, $df = 32$, $p < .05$).

DISCUSSION

Of the various independent measures, verbal intelligence was most highly correlated with the group criterion, replicating previous findings (Chester, 1974; Hoge & Stroud, 1959; Sticht, 1968). The power of the General Classification Test in differentiating reading performance, in addition to the routine availability of these test scores in service records, makes this test the primary screening measure to be used in association with remedial reading programs prior to administering any specialized tests.

Raven's Matrices appears to be highly related to development of some form of verbal skill, as demonstrated by the significant interrelationship found between the Raven's Matrices and the General Classification Test. The unique association of the Matrices with the group criterion, however, indicates that the Matrices are measuring a characteristic in addition to verbal intelligence. Earlier research has provided evidence that this characteristic is most likely perceptual, probably related to field independence/dependence (Bortner, 1965; Witkin, Lewis, Hertzman, Machover, Meissner, & Wapner, 1954). This interpretation would be consistent with previous results showing that reading improvement is related to field independence (Higgins & Gage, 1968).

Two measures of laterality, "Lateral Consistency" and "Modified Hand Use", were found to be associated with the group criterion. These results indicate that inadequate cerebral development may be related to impaired reading performance. Such an interpretation would be consistent with findings

by Witelson (1977) showing that dyslexia involves the development of spatial processing in both hemispheres to the exclusion of verbal processing, or with results of Pirozzolo and Rayner (1977) showing that reading performance among normal groups may require balanced processing between the two hemispheres. This latter research indicates that the spatial (usually right) hemisphere initially decodes visual features of words, followed by identification and naming by the verbal (usually left) hemisphere. While use of these laterality measures in screening for reading problems may be questionable, these measures may nonetheless be important in understanding some of the antecedent conditions that lead to poor reading performance.

Race was also associated significantly and independently with the group criterion, a finding that replicates previous observations made by Stuart (1967). Non-Caucasian recruits, however, improved most during the remedial reading program. Inasmuch as the initial reading scores of both groups were nearly the same (Caucasians: $M = 4.69$, $SD = 0.78$; non-Caucasians: $M = 4.56$, $SD = 0.76$; $t = 0.40$), the improvement demonstrated by the non-Caucasian group appears to involve more than an artifact related to lower baseline scores. In addition, this improvement occurred despite significantly lower General Classification Test scores (verbal intelligence) for the non-Caucasian group (Caucasians: $M = 35.50$, $SD = 6.97$; non-Caucasians: $M = 32.33$, $SD = 5.53$; $t = 3.594$, $p < .01$). Apparently, this improvement is related to some feature of the remedial training program that favors non-Caucasian recruits.

REFERENCES

BARAHENI, M. N. Raven's Progressive Matrices as applied to Iranian children. *Educational and Psychological Measurement*, 1974, 34, 983-988.

BORTNER, M. Review of the Progressive Matrices. In O. K. Buros (Ed.), *Sixth mental measurements yearbook*. Highland Park, N. J.: Gryphon Press, 1965. Pp. 764-765.

BURKE, H. R. Raven's Progressive Matrices: a review and critical evaluation. *Journal of Genetic Psychology*, 1958, 93, 199-228.

CHESTER, R. D. The psychology of reading. *Journal of Educational Research*, 1974, 67, 402-411.

CORMAN, L., & BUDOFF, M. Factor structures of Spanish-speaking and non-Spanish-speaking children on Raven's Progressive Matrices. *Educational and Psychological Measurement*, 1974, 34, 977-981.

CROVITZ, H. F., & ZENER, K. A group-test for assessing hand- and eye-dominance. *American Journal of Psychology*, 1962, 75, 271-276.

FISHER, A. H. Army "new standards" personnel: effect of remedial literacy training on performance in military service. Air Force Human Resources Laboratory Technical Report 71-13, Air Force Systems Command, Alexandria, Virginia, 1971.

HARRIS, A. J. *How to increase reading ability*. New York: McKay, 1962.

HIGGINS, N., & GAGE, G. G. Perceptual mode and reading improvement of college students. *Perceptual and Motor Skills*, 1968, 26, 1249-1250.

HOGE, D. S., & STROUD, J. B. Reading proficiency and intelligence scores, verbal and nonverbal. *Journal of Educational Research*, 1959, 52, 258-262.

HOMBERG, A., HYSHAM, C. J., & BERRY, N. H. Effectiveness of recruits assigned to academic remedial training. *Psychological Reports*, 1974, 34, 1007-1014.

PALMER, R. D. Dimensions of differentiation in handedness. *Journal of Clinical Psychology,* 1974, 30, 545-552.

PIROZZOLO, F. J., & RAYNER, K. Hemispheric specialization in reading and word recognition. *Brain and Language,* 1977, 4, 248-261.

RAVEN, J. C. *Guide to using Raven Progressive Matrices.* London: H. K. Lewis, 1965.

STICHT, T. G. Some relationships of mental aptitude, reading ability, and listening ability using normal and time-compressed speech. *Journal of Communication,* 1968, 18, 234-258.

STUART, I. F. Perceptual style and reading ability: implications for an instructional approach. *Perceptual and Motor Skills,* 1967, 24, 135-138.

WITELSON, S. F. Developmental dyslexia: two right hemispheres and none left. *Science,* 1977, 195, 309-311.

WITKIN, H. A., LEWIS, H. B., HERTZMAN, M., MACHOVER, K., MEISSNER, P. B., & WAPNER, S. *Personality through perception.* New York: Harper, 1954.

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